SUBSTITUTE SPECIFICATION
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COMMUNICATIONS SYSTEM AND METHOD

CLAIM FOR PRIORITY

This application claims priority to International Application No. PCT/DE00/03239 which was published in the German language on September 18, 2000.

TECHNICAL FIELD OF THE INVENTION

The invention relates to a method and an arrangement for setting up and clearing communications links, and in particular, for a private branch exchange and the terminals connected to it.

BACKGROUND OF THE INVENTION

Owing to the increasing amount of communications traffic resulting from the increasing number of communications subscribers, and from the increasing requirements for the amount of data to be transmitted, transmitting devices, in particular private branch exchanges, are subject to ever more severe requirements in terms of the amount of data to be transmitted by a communications link and the number of communications terminals which can be connected to one another. Present-day devices are based, for example, on the TDM method (Time Division Multiplexing) in which communications data from different connections is transmitted in respectively defined time slots. A connection between different communications partners is produced by a switching matrix which, on the basis of control information, associates incoming time slots on an incoming connection with outgoing time slots on an outgoing connection. Such switching matrices generally have a fixed size and can produce only a defined number of connections, which often makes it harder to adapt switching systems to meet the requirements. Devices such as these are subject to a further problem, in that the time slots can hold only a limited amount of data.

Figure 1 shows an example of a known private branch exchange 150 with two peripheral devices P1 and P2, to each of which a communications terminal KE1 and KE2, which operates on a digital or analog basis, is connected. These peripheral devices P1 and P2 are accommodated in the same physical area as the central device ZE1. By way of example, they are located in the same room or in the same cabinet as it. The terminals fill defined time slots in a PCM datastream (Pulse Code Modulation) with communication data. The digital or analog communications terminals KE1 and KE2 are respectively connected to subscriber line modules SLM01 and SLM02 which supply, or take from, the PCM datastream digital data which is intended for the respective terminals, or originates from the respective terminals, via time slots defined by signaling. These PCM datastreams are annotated by 100 and 200, respectively, in Figure 1. Furthermore, signaling connections are shown, which are annotated 110 and 210, respectively. It shall be noted that, in this case, this is only a logical representation and not a physical representation. However, in reality, the transport data and the signaling data are transmitted in the same connecting cable.

This figure also shows peripheral devices P1 and P2, as well as line trunk units LTUC1 and LTUC2, which control the data traffic to the subscriber line modules for the respective decentralized devices. The peripheral device P1 is supplied with signaling data via the line 110, and the peripheral device P2 is supplied with signaling data via the signaling line 210.

As can clearly be seen here, both the information to be transported and the signaling information are supplied to a central device ZE1 in this arrangement. In this case, messages 2 are gathered and distributed by a signaling device DCL, and are interchanged between the central device ZE1 and the peripheral devices P1, P2. The call processing CP controls the setting up and

clearing of connections and, for this purpose, controls, inter alia, appliance-specific interface functions DH which, for example, are in the form of program modules. In this case, setting commands 1 are produced for the switching matrix MTS. These setting commands essentially indicate which input of the switching matrix should be connected to which output in order to produce a communications link. The control and connection functions are thus carried out by a single physically integrated functional unit in the communications network.

SUMMARY OF THE INVENTION

In one embodiment of the invention, there is a method and an arrangement for providing a communications link, which ensure a high level of flexibility with regard to adaptation to the number of communications links to be provided, to the amount of communication traffic per connection, and to their physical extent, while one particular aim is to ensure that any time delay caused by switching has no disadvantageous effects on the handling of a connection.

In an exemplary method according to the invention, a connection is advantageously set up by means of call processing via an already existing fixed connection element in the transport network since this means that there is no need for a possibly time-consuming connection process in the transport network at that particular time. This advantage becomes more important the greater the number of switching stations in the transport network that are involved in the connection when setting up a connection via different connection element paths.

In one aspect of the method, the call processing is carried out particularly advantageously in decentralized switching devices since this makes it possible to achieve a high level of redundancy in the

transport network, and, in the situation where a number of such switching devices are connected to one another, between which permanently established connection element paths are set up, the setting up of a connection in the transport network takes just as long, even via a number of decentralized switching devices, as if ~~only~~ two such decentralized switching devices were involved in the setting up of the communications links. This ensures that the setting up of connections between different communication subscribers in the transport network requires approximately the same amount of time, and the number of decentralized switching devices that are actually involved in setting up the connection is of secondary importance.

In another aspect of the method, such a communications link is set up particularly advantageously by means of virtual transport network connections since, with regard to the connection times, these offer approximately the same connection setting-up times as hard-wired connections, although the transport network topology can be kept very simple and can be designed in a flexible manner, to satisfy the requirements. This leads to a considerable reduction in the amount of wiring required.

In one embodiment of the arrangement, the communications links are set up between communications subscribers via a transport network which is controlled by a control network, with decentralized switching devices in the transport network carrying out the connection tasks in the network. If there is a permanent communications link between at least two such decentralized switching devices, an arrangement such as this reduces the amount of time required to pass connections through the transport network.

Permanent, in this example, equals there is no need for setting up connections.

One aspect of the arrangement has a permanent connection in the form of a permanent virtual connection, since such permanent virtual connections can be set up independently of the network topology of the transport network at any given time, and no time is lost for setting up connections, since permanent connections are not set up dynamically as required, but may be set up once, on a static basis, independently of the requirement, and are then available.

It is particularly advantageous for the transport network to be in the form of an ATM network, since the various network components for ATM networks are already available commercially, that is to say the technical complexity for setting up a transport network is as low as desired, and the setting up of permanent virtual connections is already available as a service feature for ATM networks.

In another aspect of the arrangement, the decentralized switching devices in the transport network are connected to one another in a particularly advantageous manner via permanent virtual connections since, in this way, the time for setting up connections between any given decentralized switching devices via the transport network is approximately constant, and is independent of the number of such decentralized switching devices that are involved in the setting up of the communications link via the transport network.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiments of the invention will be explained in more detail in the following text with reference to figures, in which:

Figure 1 shows a conventional communications arrangement.

Figure 2 shows an example of a novel communications arrangement.

Figure 3 shows an example of a message sequence in a known switching system.

Figure 4 shows an example of a message sequence using time-slot-related connection information for the transport network.

Figure 5 shows a communications arrangement with permanent connections.

Figure 6 shows a communications arrangement with transport network connections via a public network.

Figure 7 shows a complex communications arrangement with virtual paths.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 2 shows an example of a flexible, high-performance arrangement for setting up communications links. By way of example, this arrangement shows the configuration of a private branch exchange 250.

Figure 2 uses the same reference symbols for the same components of the device as those shown in Figure 1. Turning now to Figure 2, it is immediately clear that this shows a separate transport network 700 and a separate control network 310/410. This configuration of a switching system has the advantage that already existing networks, such as public or private networks, can be used for the transport network. In this case, ~~only~~ the control network is routed to the central device ZE2.

The digital or analog communications terminals KE1 and KE2 are illustrated here as being connected to respective subscriber line modules SLM01 and SLM02. However, without any restriction to the invention,

terminals are also feasible, and can be integrated, in an arrangement 250 such as this, which can be connected directly to the transport network 700, without any diversion, and without any SLMO. ATM terminals or even IP-based (Internet Protocol) terminals can thus also be connected.

As can also be seen, the decentralized devices DZ1 and DZ2 have respective decentralized switching devices CS1 and CS2 which may, for example, be in the form of ATM access devices. The illustration likewise shows that the switching matrix MTS0 is no longer used for connection tasks. Instead of this, the connection tasks are carried out by the transport network.

In this arrangement, at least one control information item, which is derived from time-slot-related control information, is in each case provided for setting up the communications link for this purpose, for the respective decentralized switching devices CS1 and CS2, via the control lines 410 and 310. The figure furthermore shows that PCM data is converted to cell data in accordance with the standard for the transport network type 700, that is, for example, ATM cell data, on a respective data path 300 or 400. In this case, it should be noted that the use of an ATM network as the transport network is intended to be only an exemplary embodiment here. Ethernets, other IP links or even TDM links may likewise be used for this purpose. The choice is dependent on the intended application, and covers the entire range of available networks both in the narrowband field and in the broadband field.

Call processing is preferably carried out as a function of the transport network on the decentralized switching devices CS1 and CS2, but this is essentially restricted to the basic call functionality. Service features are in this case provided by the central controller ZE2. Connections between the various decentralized devices are controlled by the central device ZE2 via signaling.

The advantages of this control arrangement are that it can be used for both narrowband and broadband. Furthermore, the transport network will be set up on both public networks and private networks, or on a mixture of the two.

In simplified form and by way of example, Figure 3 shows a message sequence in a conventional communications system for setting up a connection between two peripheral devices, to which the terminal of a subscriber A, TLNA and the terminal of a subscriber B, TLNB are connected. The time sequence of the messages, or control messages, runs from top to bottom. First, the subscriber A goes off hook and generates the signaling information OFF HOOK. The desired communication partner is then selected by entering dialing information, which is passed on from an appliance-specific interface module DH to the call processing CP for the subscriber A.

The selection code interpretation WABE of the dialed information leads to a message SEIZURE being passed on to the call processing CP for the subscriber B. An appliance-specific interface module DH, which has the responsibility there, assigns an explicit time slot, for example ZS1 for a defined PCM data path, for example PD1, to that connection, and generates the control message TSL_ASSIGN to the subscriber line module SLM01. This control message tells the subscriber line module SLM01 the explicit time slot ZS1 and the defined PCM data path PD1 which shall be used for that connection. The explicit time slot ZS1 in the PCM data path PD1 is applicable to the connection element between the subscriber line module SLM01 and the MTS. A second explicit time slot ZS2 in a second explicitly defined PCM data path PD2 is applicable to the connection element between the MTS and the subscriber line module SLM02. The information ZS2 and PD2 is once again sent to the subscriber line module SLM02 in a control message TSL ASSIGN. Generally, TDM-based

private branch exchanges use a TDM switching matrix MTS for the physical connection of individual subscribers. A setting command PATH_CONNECT1 is sent for this switching matrix and results in the time slot ZS1 from the PCM data path PD1 being connected to the time slot ZS2 for the PCM data path PD2. The two connection elements are thus connected to form a continuous path between SLM01 and SLM02.

Figure 4 shows, in simplified form and by way of example, a message sequence between two decentralized devices, to which the terminal of a subscriber A, TLNA and the terminal of a subscriber B, TLNB are connected. An ATM network is used, by way of example, as the transport network here. The time sequence of the messages, or signaling messages, is from top to bottom. A functional unit STMA converts the time slots of the PCM datastream to a cell stream of ATM cells. In Figure 2, one such device is integrated in each of the decentralized switching devices CS1 and CS2 and, for this reason, they are not shown separately.

The sequence differs from the sequence illustrated in Figure 3 from the point where the setting command PATH_CONNECT1 is set for the TDM switching matrix. Instead of a setting command PATH_CONNECT1, a control message PATH_CONN2 is generated, which is sent to the decentralized switching devices. The decentralized switching devices then set up a connection in the transport network. When using an ATM transport network, by way of example, an ATMSVC (ATM Switched Virtual Connection) is set up by means of ATM signaling procedures.

The control message PATH_CONN2 includes the time slot and data path information ZS and PD for this purpose, and this can be taken, for example, directly from the setting message PATH_CONNECT1. In addition, the central control device states the transport-network-dependent address of the decentralized switching device to which

the connection is intended to be set up. This means that the data which is provided for the central controller as information about the transport network is restricted to the transport-network-dependent addresses of the respective decentralized switching devices. The central control device in turn determines the necessary addresses from the time slot and data path information ZS and PD. Association tables in a central database DB control the mapping of the time slot/data path to the decentralized switching device.

The control message PATH_CONN2 may also include other information, and the control message PATH_CONNECT may also be generated in a number of more specific versions. If it is intended to set up connections with different bandwidths, the control message PATH_CONN2 may also include information about the desired bandwidth. Alternatively, the bandwidth information can also be interchanged directly between the subscriber line module and the switching device.

If, after receiving the PATH_CONN2, the decentralized switching devices set up a connection in the transport network 700, the user data is then transmitted via this transport network 700. The user data stream of the data path 300/400 between the subscriber line module and the decentralized device DZ is associated with a connection between DZ1 and DZ2 by mapping the time slot details ZS and PD to form a connection identifier for that connection. This means that, although the sequences for setting up connections via the transport network on the central control ZE2 may be complicated, these addresses are passed on to the call processing of the transport network in order to produce a connection via it. Everything else is done by the transport-network-specific call processing.

According to this message sequence, the PATH_CONNECT command is thus replaced by call processing that is specific to the transport network. In order to allow

TDM-based subscribers to be connected by means of decentralized switching devices independently of the transport network, time slots are converted to transport units. This is done in a conversion unit such as an STMA, of which there is at least one for each decentralized device, and this is preferably looped into the path of the user data. An ATM-PCM gateway or an IP-PCM gateway may be provided for this purpose.

The TDM-based subscriber modules communicate with the conversion unit via, for example, connections on the backplane motherboard of the respective decentralized device. A bus which connects the modules to one another can be provided for this purpose on this motherboard. The setting commands for connection of the conversion unit are for this purpose preferably produced autonomously from the PATH_CONN2 message by the decentralized switching device.

However, the method is not restricted to dialed connections that are set up dynamically, but can likewise use an ATMPVC (ATMPVC Permanent virtual connection). The information relating to the address is then exchanged for information controlling the use of fixed connections. Furthermore, other forms of data transmission may also be used, such as IP connections.

Figure 5 shows the example of a communications system which is controlled by a control network and has a transport network 700. In these illustrated arrangements, the reference symbols are used analogously to the descriptions relating to the other figures. In the present example, three decentralized devices DZ1, DZ2 and DZN are shown, with dots being shown between DZ2 and DZN, which are intended to indicate that there may be any desired number of such devices between the decentralized device DZ2 and the decentralized device DZN, and these are likewise a part of such a communications arrangement.

Connection elements 71, 712, 72N lead from the transport network 700 to the decentralized switching devices CS1, CS2 and CSN, and are passed back via a further connection 7N7 into the transport network. This means that the decentralized devices are in this case connected in series in the transport network or, to be more precise, these decentralized switching devices are connected to these decentralized devices via the transport network, which is closed in the form of a loop.

As can also be seen, communications links exist between the individual decentralized switching devices CS1, CS2 and CSN via the transport network, with two of these being annotated 1N and 2N here. In this case, these are the virtual paths between the decentralized switching devices CS1 and CSN, or CS2 and CSN. This illustration shows that the use of virtual paths between the decentralized switching devices can result in a very complex structure. This is evident just from the description of the small number of virtual connections shown here. It can likewise be seen that the topology of the transport network can be kept very simple in comparison to this. The use of such permanent virtual paths in the transport network has the advantage that the connection setting-up times for communications links via the transport network between communications subscribers is virtually constant for any desired decentralized devices, since the fact that virtual paths have been set up means that the number of relay stations involved in setting up connections, in the form of decentralized switching devices, is irrelevant The transport network is preferably in the form of an ATM network, since the standardized service feature for setting up virtual paths already exists for networks such as these. The virtual paths are advantageously initialized and set up in the transport network ~~only~~ once, when starting up the communications arrangement, and then exist throughout the period during which this arrangement is in operation. They are used by current

communications links, in accordance with the control information which is sent via the control network, only by the call processing, which is carried out in the decentralized switching devices CS and is controlled via the control network, which is not illustrated here.

Figure 6 shows a further communications arrangement comprising three decentralized devices DZ1 to DZ3, in which central switching devices CS1 to CS3 are arranged. Virtual communication paths 12, 23 and 31 exist between the decentralized switching devices. In this case, the transport network 700 is in the form of a public ATM network. This means that the virtual paths 701, 702 and 703 run via a public network. In a situation where the decentralized switching devices CS1 to CS3 are connected to one another via a public network and no virtual paths are established between them, it is possible, when setting up a connection, for the delay times via the transport network to become so great that the standardized connection setting-up times can no longer be complied with, as defined in the communications standard used in such a communications arrangement. The setting up of virtual paths in the transport network, particularly in the case of public transport networks, thus advantageously ensures that the connection setting-up times via the transport network can be kept short.

Figure 7 shows a more complex communication arrangement, in which all the decentralized switching devices are connected to one another by virtual paths. For the sake of clarity, the decentralized switching device CS1 is shown completely, and the other decentralized switching devices are numbered successively in sequence, by the numbers 2 to 16.

In this case, the transport network is in the form of a matrix-like row and column structure, which connects the individual decentralized switching devices to one another. Of these, only DZ1 is shown in the present

example since, in the wider context, these contribute nothing to the understanding of the figure. The transport network thus comprises columns 701, 702, 703 and 704, which connect respective decentralized switching devices CS1, 5, 9, 13; 2, 6, 10, 14; 3, 7, 11, 15 and 4, 8, 12, 16 to one another. In the rows of the network, CS1, 2, 3, 4 are connected to one another by the transport network via 107, 5, 6, 7, 8 are connected to one another via 507, 9, 10, 11, 12 are connected to one another via 907, and 13, 14, 15, 16 are connected to one another via 1307. Even the use of 16 decentralized switching devices in a communications arrangement thus results in a highly complex transport network topology. However, the structure becomes disproportionately more complex if virtual paths are set up between the individual decentralized switching devices in order to keep the connection setting-up time via the entire communications arrangement constant between communications subscribers and any given decentralized devices. The virtual paths for a single decentralized switching device 6 to the other decentralized switching devices are shown here. However, it should be noted in this case that such a star-shaped virtual path configuration exists between the decentralized switching devices 1 to 16. In detail, virtual paths 61, 62, 63, 64, 616, 613, 69 and 65 originate from 6 going to the other decentralized switching devices, although it should be noted that, in order to make the illustration clearer, this figure does not show the virtual paths. In order to ensure a short connection setting-up time for communications links via this communications arrangement between the decentralized switching devices it is, however, necessary for the decentralized switching devices to be connected to the other decentralized switching devices via virtual paths.

An arrangement such as this in conjunction with the procedure for establishing a communications link ensures that the connection setting-up times and the

delays associated with them between the individual decentralized switching devices occur when starting up such a communications arrangement, during which process the virtual paths are initialized via the ATM network, while these times are short when actually setting up a communications link between communications subscribers who are connected to any given decentralized devices, since these links run via virtual paths.